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Type of Organization: College or University

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Project Title: In search of holistic indicators of aquatic ecosystem health

Project Category: Emerging Issues

Rank by Organization (if applicable): 0

Total Funding Requested ($): 93,498 **Project Duration:** 2 Years

Abstract:

The Cuyahoga River watershed in northeast Ohio is environmentally impaired and has been identified as an Area of Concern. We propose to use fluctuating asymmetry (FA) for developing ecological indicators that can indicate general health of the aquatic ecosystem. Fluctuating asymmetry, a measure of random deviation of organismal traits from perfect bilateral symmetry, can be induced by environmental or genetic stress. We plan to survey FA of bilaterally symmetric traits of aquatic plant communities from 30 sites of Cuyahoga River watershed located in north eastern Ohio. These sites were selected carefully to represent the entire watershed and different levels of environmental impairment. The purpose is not only to monitor the status of the ecosystem health of the watershed, but also to identify the sentinel species or biomarkers or ecological indicators that demonstrate greater levels of FA in response to pollutants from point and non-point sources. A transplant-replant experiment will be carried out between the polluted downstream and upstream control sites using the indicators to verify the effects of pollutants on the FA. A pollution index (PI) will be calculated as the ratio of FA in the control and polluted sites. A greenhouse experiment will also be carried out with the indicators to test the effects of pollutants such as mercury and lead on FA. The results of the greenhouse experiment will be compared with that of the natural communities.

Geographic Areas Affected by the Project

States:

- ☐ Illinois
- ☐ Indiana
- ☐ Michigan
- ☐ Minnesota
- ☐ New York
- ☐ Pennsylvania
- ☐ Wisconsin
- ☒ Ohio

Lakes:

- ☐ Superior
- ☐ Huron
- ☐ Michigan
- ☒ Erie
- ☐ Ontario
- ☐ All Lakes

Geographic Initiatives:

☐ Greater Chicago ☒ NE Ohio ☐ NW Indiana ☐ SE Michigan ☐ Lake St. Clair

Primary Affected Area of Concern: Cuyahoga River, OH

Other Affected Areas of Concern:

For Habitat Projects Only:

Primary Affected Biodiversity Investment Area: Western Lake Erie/Oak Openings

Other Affected Biodiversity Investment Areas:

Problem Statement:

Although biomonitoring is now considered as an indispensable tool for monitoring environmental impacts of hazardous substances, the potential of cost effective and efficient ecological indicators for monitoring aquatic ecosystems has not yet been realized fully. The ecosystem health of the Cuyahoga River in northeast Ohio is critically imperilled, and has been declared as an Area of Concern. We propose to develop aquatic macrophytes as ecological indicators for measuring the impacts of hazardous substances such as mercury and lead in the Cuyahoga River ecosystems. Compared to other biomarkers or ecological indicators, the proposed indicators will be easy, cheap, rapid, and nondestructive.

Proposed Work Outcome:

We have established 30 sites within the Cuyahoga River watershed and Cleveland Metropolitan Area for long-term ecological studies. These 30 sites represent 112,000 ha of the watershed. Although we have sampled ciliate, diatom, macro-invertebrate and fish communities from these sites, we have not sampled aquatic macrophytes. We propose to conduct a reconnaissance survey of aquatic macrophytes present in these sites and quantify fluctuating asymmetry (FA) of selected aquatic macrophytes. The macrophytes of the Cuyahoga River include Sagittaria (arrowhead), Elodea (pond weed), Ceratophyllum, Vallisneria (tape grass), Lemna (duck weed), Wolffia (water meal), etc. In selected sites, the concentration of mercury and lead in the sediments and plant tissue samples will also be quantified and correlated with the indices of FA.

FA measures the random deviation from perfect bilateral or radially symmetrical morphological traits. The magnitude of FA often increases as an increased anthropogenic stress disrupts developmental processes of organisms. Thus FA can be considered as a stress response in the ecosystem, and the most sensitive species that readily respond to a stress caused by pollutants can be considered as ecological indicators or biomarkers. Alternatively, we can diagnose the health of an ecosystem if we quantify FA of the resident ecological indicators in the ecosystem. The measurement of FA is quick, simple and cheap. Simple counts or measurements of left and right side of a meristic or metric trait provide an index of FA.

A reciprocal transplant-replant experiment will be carried out between the polluted downstream and upstream control sites using the selected indicator species. The results of transplant-replant experiment will be used to verify the effects of pollutants on the FA. A pollution index (PI) also will be calculated as the ratio of FA in the control and polluted sites. A greenhouse experiment will be conducted to test the effects of mercury and lead on FA of the indicators. These indicator species will be grown in a number of aquaria with different pollutant treatments. The treatments include three concentration levels for each of the pollutants accompanied by a control without any contaminant. Each treatment will be replicated five times. As the greenhouse environment may reflect ‘ideal' growing condition, we would also be able to compare FA between the natural variation in FA in the greenhouse plants and those in the relatively clean upstream control sites.

Project Milestones:	Dates:
Project Start	06/2000
Reconnaissance survey	08/2000
Set up tranplant-replant experiment	07/2000
Set up greenhouse experiment	08/2000
Chemical analysis	12/2000
Data collection	09/2001
Data analysis and report preparation	04/2002
Project End	05/2002

☐ Project Addresses Environmental Justice

If So, Description of How:

☒ Project Addresses Education/Outreach

If So, Description of How:

Education is an integral component of the project. One graduate student and two undergraduate students will be trained in pollution monitoring and phytoremediation. The results of the project will be presented in local, national and international conferences. At least three papers are expected to be published in peer-reviewed scientific journals.

Project Budget:

	Federal Share Requested ($)	Applicant's Share ($)
Personnel:	39,766	16,368
Fringe:	3,751	4,010
Travel:	7,276	0
Equipment:	0	0
Supplies:	16,750	0
Contracts:	0	0
Construction:	0	0
Other:	1,300	11,348
Total Direct Costs:	68,843	31,726
Indirect Costs:	24,655	10,148
Total:	93,498	41,874
Projected Income:	0	0

Funding by Other Organizations (Names, Amounts, Description of Commitments):

Description of Collaboration/Community Based Support:

The project will be carried out in collaboration with the Woodlake Environmental Field Station in the Cuyahoga Valley National Recreation Area (CVNRA) and John Carroll University. Letters of support will be submitted with the full proposal.